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*THE RELATION OF MODERN CHEMISTRY TO MODERN MEDICINE.**

THE history of the relation of chemistry to medicine is interesting to the physician as well as to the chemist, but has been studied mainly from the standpoint of the latter. From the remotest periods chemistry, or, more accurately, the crude science or art which preceded it, found application in two directions, first, in the treatment of metals or ores or similar bodies to produce something of greater value, and secondly, in the curing of disease or prolonging of life. In both fields of effort the attempts were and remained through some thousands of years of the simplest character. Even in the work of Galen, who flourished two hundred years after Christ and who has been styled the first of the great physicians, there is little which suggests any attempt toward a systematic knowledge of chemical substances. According to the philosophy of the Egyptians and Greeks then current, all things, including the human body, were made up of a limited number of elements or qualities, usually four. With the proper mixture of these the body remained in normal health, but with the qualities out of proportion disease followed which must be attacked through the corrective agency of medicines. Galen's medicines were mostly simple vegetable infusions or extracts of roots, barks and leaves, and the term galenical we still retain to describe the remedies which are essentially indefinite mixtures secured by processes similar in principle to those introduced by

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the Egyptian. After 1,700 years of progress we still find many disciples of Galen among us, and the remedies which are 'purely vegetable,' or advertised to be, find yet among the ignorant the largest sale.

The beginnings of chemical and medical knowledge came to western Europe through the Arab conquest of Spain and in that country were nurtured through many years. Alchemy and theology, however, developed more rapidly and the learned showed greater interest in the transmutation of metals and the saving of souls than in the perfection of means for curing the ills of the body. The system of Galen remained adequate for the needs of physicians through a period of 800 years following the Moorish conquest. It could not be otherwise with miracle shrines in every village and burning fagots for all that doubted.

In the sixteenth century we recognize the first systematic attempts made to improve on the materia medica brought down from Greece and Egypt. Paracelsus began to teach the value of artificial products in the curing of disease, and, although meeting with great opposition, he with his pupils gradually built up a creed which flourished a century and a half. Paracelsus, familiar with the doctrines of the alchemists, and through extensive travels well acquainted also with the operations in metallurgy in many countries, set about to apply the gradually accumulating knowledge to the production of chemical remedies for human ailments. He promulgated a crude theory of the normal conditions of the body and, like Galen, assumed that variations from that normal could be corrected by chemical agents. Civilized as well as uncivilized man has usually been a believer in materia medica, and the notion that arsenic or mercury or antimony or sulphur could build up what disease had torn down possessed an element of plausibility that rapidly attracted adherents. Medicine became, in effect, a branch of applied chemistry and the chief energies of physicians were bent in the direction of medication rather than toward the development of diagnosis. We can not wonder at the subsequent failure of the system, since it grew into a kind of exaggerated empiricism not far removed from quackery. Indeed, it is difficult to realize at the present time how the iatro chemistry developed and flourished as long as it did. It must be remembered that chemical analysis was then quite unknown, and of chemical compounds only such were in use as could be easily made from a small number of native minerals and the simple inorganic acids and alkalies then available. Of the substances called organic very few had been discovered. A system of chemical therapeutics based on so slim a foundation failed, then, because of the wide divergence between what was confidently promised and what experience showed was practically realizable. But while no good came directly from this approach of chemistry to medicine, the indirect results were more important, since the large number of physicians turned chemists accomplished the discovery of many new substances.

We hear little more of the influence of chemistry on medicine through the one hundred years following the decline of the iatro school. Not, indeed, until the time of Lavoisier and his colleagues, when the explanation of the respiration process in its relation to oxidation and combustion and the investigations by the calorimeter on the origin of animal heat called again attention to the possibilities of chemistry in the development of medicine. About the same time came the discoveries of Galvani and Volta, the importance of which was soon recognized. Those were inspiring times for the real science of chemistry newly born, when each day, almost, added some new fact to the rapidly filling store-house. The learned in all lands stood amazed at

the news brought in the journals or just as often in the letters from Paris, or London or even from little Weimar, where the Wahlverwandtschaften reflected the curiosity and enthusiasm of the epoch. There was for a moment danger that the medical-chemical history of the seventeenth century would repeat itself at the beginning of the nineteenth, when oxygen and the galvanic cell began to be hailed in some quarters as offering the key for all mysteries and the cure for all diseases. But the three hundred years following the rise of Paracelsus had produced a new race of thinkers, and only temporarily could men be brought away from a now well-developed and necessary tendency—the collection and investigation of facts.

It is not my purpose to sketch the fruitful work of the next half century, as I wish to speak particularly of a later period, but it must be recalled that the pioneer labors of Dumas, Liebig and Wöhler in organic chemistry made possible the later developments in physiological and pathological chemistry. In this period of great scientific activity it must be admitted, however, that the practical influence of chemistry on medicine was not very great. Each discipline developed largely in its own way, and while the practitioner recognized in physiology and physiological chemistry sciences of great interest and beauty, he was not very clear as to what uses he could make of them except in a few limited directions. Chemistry had become completely divorced from pharmacy and cared nothing for the preparation of remedies, and the applications of chemical analysis which might prove an aid in diagnosis were as yet few and far between. In the eyes of the medical practitioner and medical student chemistry was very theoretical, to be tolerated rather than to be cultivated. I have elsewhere called attention to the almost futile efforts to build up courses in chemistry in the early medical schools of the United States. The efforts failed here as, practically speaking, they failed elsewhere at the same time because of the lack of immediate relationship of the one science to the other. A medical man might just as well be asked to study botany or zoology as chemistry, as far as any really helpful practical application was concerned, excepting, perhaps, in two or three simple tests.

And so the situation remained until about 1860, when the views of Pasteur on alcoholic fermentation and the isolation by the German physiologists of several active soluble ferments or enzymes of the animal body began to attract wide attention and point the way toward an explanation of many processes taking place in the organism. With the growing recognition of the character and importance of the work of the enzymes I think we have the first real tangible evidence of the dependence of medicine on the new chemistry. The doctrine of the ferments as applied to the chemical changes taking place within the body is one, apparently, of indefinite extension, and at the present day, after forty years of trial, it seems more than ever likely to hold its own and be capable of even wider development. In passing, I must add that it would not be fair to claim that the great advances just suggested were all due to the efforts of chemists. On the contrary, many of them were conceived and largely worked out by men who had been trained primarily in medicine rather than in chemistry.

In speaking of the relations of modern medicine and chemistry it may be recognized that they are essentially of three kinds. We have first the very simple and so-called practical relation in which chemistry becomes an aid to medicine in the way of diagnosis. Here analytical chemistry is alone concerned and the chemist is called

upon to determine by tests the normal or pathological character of some body fluid or excretion about which the physician must have information before he can make a correct diagnosis. This work is, of course, extremely important, but, as ordinarily applied, it calls, perhaps, for the lowest order of chemical knowledge and represents the lowest requirement which can be made in the chemical education of the medical student. In the hands of the medical practitioner chemical analysis degenerates usually into a routine performance in which a few very simple and accurate tests are carried out in a marvelously inaccurate manner. Medicine is as yet very far from availing itself of the great aid which analysis is ready to offer in the solution of its practical problems in every-day experience, and this is largely due to the fact that in most of our medical schools instruction in chemistry stops before the student has become sufficiently familiar with the real science to feel at home in its applications. All medical students learn something about sugar and albumen and they usually are able to apply their laboratory acquisitions in later practise. But the same can not be said of their experience with acetone or indican or the aromatic sulphates, for example. These, too, certainly have a meaning, and the student has probably learned the tests for them in his laboratory work. But, unfortunately, their relations to disease are less tangible; their bearings do not become clear without a greater mental effort, and hence the once acquired facility is allowed to slip away, or to degenerate into a valueless routine, in which an assumed accuracy may be wholly illusory.

Supposing, however, that the medical man's knowledge of analytical chemistry is full enough and satisfactory for the purpose, and that he continues to practise and even improve upon the tests which he has learned, something more is still desirable or necessary. Much that should be possible in diagnosis is often lost because of the difficulty in connecting that which is shown by analysis with what it indicates or depends upon. The value of analytical chemistry in medicine soon reaches a limit unless it is accompanied by a very much fuller knowledge of general physiological chemistry than is usually acquired. And, moreover, while routine analytical work may be extremely important, in many cases really essential to diagnosis, it is far from representing the major service which chemistry may render to medicine. By analytical tests we are able to measure some of the effects of certain reactions taking place within the body, but the causes of the reactions and the relations of the things reacting involve ordinarily much deeper problems than those of simple analysis. An illustration may be given. Some years ago Ehrlich introduced a valuable test in the examination of urine which is commonly known as the diazo test, and which depends on the formation of an azo color when a certain reagent is added to the urine. To complete the reaction some aromatic product must be furnished by the secretion, and the presence of this was supposed at one time to be indicative of a definite pathological condition. Later, through more extended clinical observations, it seemed possible to connect it with still other conditions, and then a long discussion arose as to the limits and usefulness of the reaction. Among the many papers published in the discussion some have been good and some bad, even absurdly bad, because they overlooked wholly the essential conditions of the reaction considered from the chemical standpoint. It is evident that many of the writers on the subject were unfamiliar with the chemistry involved in the diazo combination and were, therefore, led to absurd expressions. To fairly comprehend a problem of this kind

a good knowledge of elementary organic chemistry is necessary, and it is essential also that one should have some idea of the part played by bacteria in the organism in producing complex aromatic substances from the disintegration of proteins, since the indications here are often of great importance.

And this brings us to consider the second type of relation between chemistry and medicine, a relation which involves the question of organic synthesis or disintegration in the animal body. At an earlier stage in the discussion it was assumed that, Topsy like, things 'just growed that way.' Later the mysterious electricity and still more mysterious vital force were called in to account for everything not easily explicable by known chemical or physical means. While it is probably true that many of the phenomena of life are and will remain quite beyond our power of explanation, and that here as elsewhere we must accept the *ignoramus* and *ignorabimus* of Du Bois Reymond as final, we are coming, on the other hand, to the recognition of the comparative simplicity of other problems, the solution of which falls within the province of the new physiological chemistry. Medicine will be the chief gainer by these investigations.

It was certainly an auspicious day for chemistry and medicine also when Pasteur developed his biological theory of alcoholic fermentation. Not long after came the work of Kühne, Brücke and others on the enzymes, already referred to, and finally Buchner to clearly demonstrate the long-suspected enzymic character of the yeast ferment. Practically all recent work in this direction has gone to show that so-called organized fermentations are all dependent in turn on enzymic ferments contained within the cells. This distinction may probably be made: in the yeast fermentations, for example, the sugar to be converted is drawn into the cell, and the products, alcohol and carbon dioxide, formed by the zymase, are in turn excreted. In diastasic and similar fermentations, on the other hand, certain cells produce an active ferment which is discharged to do its work outside the generating cell. The difference is thus seen to depend on the place where the reaction occurs, which is not a very important point. The ferments are essentially complex chemical substances, able to bring about various reactions nearly all of which are of exothermal character. Of the nature of many of these reactions we have pretty accurate knowledge, although of the exact mode of action of the enzyme itself our knowledge is scanty. For the present purpose, however, it is sufficient to recognize that these reactions are chemical and we are in a position to trace their bearing on medical problems.

The simplest problems of enzyme action we have in the work of some of the so-called digestive ferments. In the changes wrought in starch by the saliva and by one of the pancreatic ferments the chemical action is one of hydrolysis and very similar to that occurring commonly in the vegetable world. In the germinating seeds, when starch becomes sugar to feed the developing plantlet, water is added through the aid of diastasic ferments, and later, in the ripening of many fruits the same kind of a reaction takes place. These effects, however, are not peculiar to the enzymes; experiment shows that the same starchy substances acted upon by weak acids pass through the same series of changes occurring in the body, and even prolonged heating with water has the same general effect. The hydrolytic and purely chemical nature of carbohydrate digestion becomes at once apparent. What happens in the digestion of fats is equally simple. Here, too, hydrolysis plays the most important part and the work of the lipase enzymes can be

duplicated in the vegetable kingdom and also in the laboratory by the aid of the simplest of inorganic reagents. A far more difficult problem for a long time was to account in any way for the changes taking place in the digestion of proteins. The presence of a proteolytic enzyme in the gastric juice was recognized definitely by Brücke over forty years ago, and about the same time a substance called trypsin was found in the extract of the pancreas. These substances acting on proteins under certain conditions convert them into a series of intermediate and end products about which an enormous literature has been developed. In the course of the long discussion it was discovered that many of the products which are formed by the enzymes may be obtained by the action of weak acids or alkalies, or water even at an elevated temperature, on the original proteins, and finally it was shown that an increase of weight follows in these cases as in the case of the addition of water to starch. All this evidently places the phenomena of protein digestion in the group of hydrolytic reactions, along with the much simpler starch and fat reactions. The digestion processes are, therefore, chemical, and the only thing about them which remains mysterious is the fact that from one set of body cells a ferment working in acid medium is produced, while from a second set of cells a somewhat similar ferment working in an alkaline liquid is secured. Furthermore, all these changes seem to belong to the great group of catalytic reactions, of which more will be said presently.

The general character of these operations was pretty distinctly fixed years ago and their importance clearly recognized. The chemical nature of the several enzymes themselves, however, is not known; the commercial products called pepsin, diastase, etc., are merely crude mixtures of which the active substances make up but a small part. The investigation of the properties of these enzymes opened the way for the study of other reactions peculiar to the animal organism, which are likewise undoubtedly of enzymic origin. In fact, the view is gradually gaining ground that by far the largest number of the body functions involve in some way the action of enzymes. The digestion phenomena are among the simplest and most readily observed, but patient investigation has brought to light other reactions as truly enzymic as these. In the liver alone there are no less than ten well-defined processes in progress, in the initiation of which enzymes are concerned. For the maintenance of the wellbeing of the body the proper performance of these processes is as essential as is digestion itself. In a general way most of these processes have been known or suspected for years, but they were supposed to depend on some peculiar vital action of the liver cells themselves. The situation here is analogous to that regarding the mode of action of the yeast cell, but most investigators now consider the enzymic or chemical theory as well established. The liver may, indeed, be compared to a laboratory in which important syntheses and decompositions are constantly taking place. Some of these are of such a character that they may be easily duplicated *in vitro*, while others appear to be practically beyond artificial control. What is true of the liver is true of other organs where matter undergoes change. In the blood the presence of several of these ferment agents has been shown.

These various observations have had an important bearing on a discussion which has been of long duration. Since the days of Lavoisier physiologists have been trying to define the means by which the oxygen taken in by the lungs effects the oxidation of the food stuffs. Sugars and starches consumed yield finally water and carbon

dioxide. In this oxidation just as many heat units are liberated as would be set free by the same kind of combustion in a calorimeter. If work is done at the expense of the consumed food stuffs it has been found that the animal makes a somewhat greater return of mechanical energy than is possible with the best machines known. But while all this is interesting and important, it leaves the main question still unanswered: How is it accomplished? To effect such oxidations artificially would require very high initial temperatures. We can not burn sugar by the aid of the oxygen of the air except by reaching first a certain kindling temperature. To burn fats or proteins would be equally difficult. Yet in the animal body, and in the presence of fluids with a mean temperature below 40° Centigrade, the oxygen given up from the arterial blood accomplishes these combustions continuously and with a regularity corresponding with that of respiration. The theories advanced to account for this oxidation have been many and all more or less unsatisfactory. By some it was supposed that the oxygen was first thrown into an active form like ozone, for example. The old Berzelius notion of catalysis was even fifty years ago advanced as a hypothesis, but nothing definite was suggested as to the nature of the catalytic agent. It is an interesting fact that after years of fruitless theorizing chemists are coming back to the idea of catalysis, but from a very different standpoint. The peculiar catalyzing agents active in so many ways in the body are now often assumed to be some of the so-called oxidizing ferments or oxidases. The theory of the oxidases is of rather recent development and there seems to be no question of the existence of these active principles in many vegetable products. Their actual presence in the animal fluids is not so readily demonstrated, but as a result of experiments a great many investigators have been gradually brought to accept this idea as a fact. What Ludwig forty years ago pointed out as likely is actually coming to pass. Chemical physiology is becoming largely a study of catalytic reactions.

Among all the animal oxidations great interest attaches to the combustion of sugar in man. In the digestion of carbohydrates some hexose sugar is finally produced and absorbed and then carried by the portal circulation to the liver. There it is temporarily stored up as glycogen, and, as required, is thrown out into the blood stream again to be oxidized for the needs of the body. Normally this oxidation takes place very quickly and no accumulation of sugar in the blood follows. But under certain conditions the oxidation of the sugar becomes very imperfect or fails entirely, and to maintain the proper osmotic pressure in the blood the excess of sugar escapes by way of the kidneys. This is the situation in the disease known as diabetes mellitus. There are few pathological conditions on which more has been written. We can not say yet that the ultimate cause of diabetes is known, but many facts have been established by chemical investigation and quite recently the work of Cohnheim has shown, apparently beyond question, that for the normal oxidation of sugar the action of two enzymic bodies of distinctly different origin is required. One of these, as might naturally be expected in the light of earlier knowledge, is furnished by the pancreas, while the other comes from the muscles. The oxidation takes place, or may take place, in the fluid surrounding the muscular fibers. Cohnheim has shown that the cell structures as such are not concerned in this oxidation, as it may be brought about in clear filtered solutions from mixtures of finely ground muscle and pancreas. It is, therefore, a chemical process and one of the most interesting thus far studied. Not the least interesting and important fact

connected with the observation is this, that two bodies at least are concerned with the sugar in the reaction. One of these may act as a catalyzer for the other, or, taken together, both may act in the manner of the complement and intermediary body of Ehrlich, of which more will be said below. The point of importance here is that the theory of this oxidation has shifted around so as to become a strictly chemical one. As long as some specific action of the cell was called in to account for the observed phenomena the biologist rather than the chemist was interested in the solution of the problem. It now appears that the chemical factors are the main ones to be considered in the final effect. It remains, of course, true that the oxidizing ferments must be always the products of cell action, but the important idea suggests itself that they need not necessarily be produced by the same body which is later to use them. If investigators succeed in showing more specifically the nature of the two substances, it may be found possible to secure them from other animals and introduce them when needed, much as antitoxins are introduced.

Many of those present doubtless recall the beginnings of what is known as the germ theory of diseases. From his success in developing a satisfactory theory of alcoholic fermentation, which became of vast importance in the brewing and wine industries, Pasteur was led to study the causes of failure often noticed in practical fermentation. Beers and wines sometimes become diseased and spoil in the process of making. They turn sour, or for other reason become unfit for use. The explanation of this was found to lie in the presence of foreign ferments which induce new reactions. As a preventive of such diseases sterilization and pasteurization processes were suggested and have become common in many industries besides those for which first developed. From sick beers and wines Pasteur was led to study sick silkworms, then a question of great commercial interest in France, and found the cause of the malady and later a method of prevention. Following this wonderful work, men began to look for microorganisms elsewhere, and in the course of a few years specific bacteria were described as the active agents in inducing cholera, anthrax, tuberculosis and other dread diseases. According to the germ theory, the invasion of certain tissues of man or the higher animals by these bacteria is the real cause of the disease in question. It must be recalled that these organisms are extremely minute. Many millions of them would be required to produce the volume of a pin head, and that anything so small could give rise to cholera or typhoid fever seemed at first utterly unreasonable. That these minute things are the actual agents of many diseases there can now be no doubt. It remains to discover how they act. At first their effects were assumed to be largely mechanical and in the direction of the destruction of tissues, but in many cases the tissue destruction is of secondary importance. The notion gradually developed that many of the disease-producing bacteria are active through the poisonous principles or toxins which they elaborate. The toxins are complex chemical substances resembling in properties some of the alkaloids, or possibly belonging to the group of enzymes. At any rate, as soluble chemical agents, they are able to diffuse throughout the body and interfere with its normal functions. We appear to have then a chemical theory back of the germ theory and this development is proving of the highest importance from both theoretical and practical standpoints. The theory of the production of toxic substances by the bacteria involved, of course, no new assumption. Chemists had been long fa-

miliar with the production of poisonous matters by other vegetable cells, and the development of ptomaines, or cadaver poisons, was sufficiently well understood to suggest at once the formation of analogous substances in the living organism. Hence the doctrine of the toxins as the important chemical factors in the causation of certain diseases, when once clearly stated, made rapid headway and is now very generally admitted and recognized. The investigation of bacterial intoxications has become a chemical problem of rare fascination and importance, and through this work entirely new departments of research have been opened up, bringing into the practise of medicine, as well as into the literature, new ideas and new methods. The development of the notion of toxins was followed by that of the antitoxins, the potent agents which check or prevent the harmful work of the toxic ferments. The theory of the action of these substances on each other is largely a chemical one and is founded on a basis of experiment. It appears that in many cases studied toxin and antitoxin combine in fairly definite and constant proportions, which would necessarily be the case if their union is in any sense a chemical one. The behavior of one with the other has been compared to that of an acid with a base, but it is more like the combination of active salts to form complex double salts of entirely distinct properties. The extreme toxicity of potassium cyanide, for example, is modified by combination with iron compounds to produce the salt of a new and far less potent acid.

Few topics in medicine to-day attract the attention given to natural and acquired immunity. The history of scientific investigation in this field is not old, but already its literature has become enormous. Immunity may exist with reference to bacteria, or to the toxins produced by bacteria, and in either case it may be inherent or natural or it may be imparted. The natural immunity of many animals to bacterial invasion does not necessarily involve any direct chemical action, and in the most widely accepted notion yet advanced to account for this kind of immunity certain large cells of the body, which have been called phagocytes, or devouring cells, play an important part. These seem to seize upon the foreign invader and destroy it by a kind of digestive process. Such a property is observed in the large white corpuscles or leucocytes of the blood, and it is likely that a chemical action is indirectly concerned here. The cells may produce some specific chemical substance which is a poison for the attacking bacteria. It has also been held that in the gradual and spontaneous disintegration of these cells substances are thrown into the serum which have the real germicidal action. These are the alexins of Buchner, and in the theory of the latter they are enzyme-like substances. What the exact facts are we do not know, but I refer to the point to emphasize the growing tendency to look for the chemical factor in every body phenomenon.

In the study of acquired or developed immunity to bacterial toxins we find the most ambitious introduction of purely chemical theories. In this field the labors of Pfeiffer, Buchner, Bordet, Ehrlich and others are preeminent, and in all cases the chemical idea appears as an essential factor. This is peculiarly true of the so-called 'side chain theory' of Ehrlich, which at the present time attracts the widest attention. Years ago Pasteur introduced the notion of molecular asymmetry into chemical science and pointed out in effect the importance of the conception of configuration in dealing with certain problems. In 1894 during the progress of his famous investigations on the bodies of the sugar group, Emil Fischer published some remarkable

papers on the behavior of certain enzymes in the fermentation of sugars, in which he pointed out that in order to work as ferments the enzymes must possess a certain stereo-chemical structure, bearing a definite relation to the stereo-chemical structure of the sugar. Without this relation fermentation can not take place. In order to make his meaning plain Fischer employed a figure which has since become famous. He said, in speaking of certain glucosides: 'Enzyme and glucoside must fit into each other as a key into a lock in order that the one may be able to exert a chemical action on the other.' In one of these papers Fischer suggests that the idea of related molecular configuration of enzyme and fermentable body may prove of value in physiological investigation as well as in chemistry. We have apparently in this prediction of Fischer made ten years ago the basis of the Ehrlich hypothesis.

Without going into minute details, the Ehrlich notion of bacterial or toxin action on the cells of the body, and immunity from the same, is briefly this. Bacteria, animal cells and toxins are all complex aggregations of more or less complex molecules. The latter have certain configurations dependent on the presence of side chains or side groups, to borrow an expression from organic chemistry. These side chains are directly or indirectly the points of attack or defense in the action of the several bodies on each other. In order that a substance may behave as a poison or toxin to cells of the body, both cells and toxins must, therefore, possess certain reciprocal configurations. It has been suggested by Ehrlich that it is through the presence of these side groups that the cells absorb their necessary nutriment and elaborate new structures from it. Some of the side chains may be constructed to combine with fats, some with carbohydrates and some with proteins, but in the presence of toxins or bacteria with the right kind of side chains combination with these may take place instead. Certain phenomena seem to indicate that this combination is not a direct one, at any rate not always direct, and the conception of an intermediary body or linking complex has been developed. This intermediary body must itself possess two groups with special configurations; one of them fits it to combine with the cell, while the other brings about the combination with the toxic molecule.

The complicated nomenclature called into existence to describe and express satisfactorily the conceptions of this interesting theory appears at first sight a great drawback in the way of readily following it. There are cytophil groups and toxophil groups, and both of these may be called haptophorous groups because they carry the combining or uniting property. Other terms employed sound equally strange to the chemist, but a little patient study discloses what is meant and we are obliged to recognize in the new doctrine an important widening out of biochemical science. Of course no one assumes that the theory, or the various other theories which have grown up around it, will persist in the present form. The chemistry of living things is admittedly the most complex of all kinds of chemistry. For new ideas we must have new figures and these of Ehrlich in the side chain theory are not more unreal than were the figures employed in the early days when a general chemistry began to be evolved from the atomic theory of Dalton. Besides this, the stereo-chemical speculations of Ehrlich and his school present for the first time a tangible working hypothesis to account for the phenomena of toxicity and immunity. In many respects the hypothesis or theory will suffer modification and so discard what is useless or false. But already it has stimulated investigation enormously and created in

medicine a situation analogous to that created in chemistry by Pasteur and van't Hoff and developed largely by the latter and Fischer. In this new medical chemistry there is the same distrust to overcome which was encountered by van't Hoff in the first years after the publication of his work on chemistry in space. It may be recalled that Kolbe especially was very bitter against what he called idle speculation and this is the attitude to-day toward an attempt to explain obscure phenomena in etiology in chemical language. It is true that complete chemical explanations of pathological conditions are in most cases not yet possible, but the bold speculations of Ehrlich, Buchner, Bordet and the other scientists who have contributed to the discussion deserve cordial recognition. It is no fatal objection to their hypotheses that the leaders in the various schools differ as to details. The fact of permanent value is that they are all at work on a theory which is essentially chemical.

The organic chemistry of the protein substances has advanced far enough to show that these bodies are complex aggregations of certain large and small groups. The elimination or destruction of some of these groups may not necessarily mean destruction of the whole molecule. Doubtless it may remain a protein with several of the smaller groups lost. Outside of the animal or vegetable organism there is apparently no simple way of regenerating what has been obliterated. In the living tissues, however, the proteins may possess the power of self-regeneration by some kind of a synthesis; the loss of a few amino groups, for example, need not be followed by the decay of the whole. These amino groups may be convenient points of attack for certain reagents, but not for others. They are, in a sense, the toxophil groups by means of which outside connection is made, but if the proper attacking agent is not used the protein remains unchanged. It is also true that certain reagents may increase the stability of the protein and inhibit practically its destruction under given conditions. In general such molecules possess greater stability in presence of their dissociation or reaction products. Conceptions somewhat analogous to these are included in the Ehrlich immunity theory, according to which some of the separated side chains from the over-stimulated cell behave as antitoxins to check further action.

In still another important direction the influence of chemistry is being felt in medicine and it is the new physical chemistry which is now the vitalizing force. In one of his earlier papers van't Hoff called attention to what this kind of chemistry might do for physiology, and in recent addresses he has come back again to the subject. Ostwald has many times, and even more strongly, pointed out the importance of physical chemistry to the progress of medical theory. As long as physiology alone was concerned in this advance the influence on practical medicine remained somewhat problematical. The clinician has been almost as skeptical about the value of pure physiology as he has been about the value of pure chemistry. But many of the newer developments from the theory of solutions have been found applicable in questions of pathology, the recognition of which fact is of growing importance. A few of these so-called practical applications may be mentioned here.

It is a well known yet always interesting fact that the osmotic pressure of the blood remains within narrow limits a constant. A slight increase following meals or a decrease following large consumption of water is speedily corrected through the activity of the kidneys. The importance of this constancy in osmotic pressure appears when it is recalled that all the other organs of the

body are more or less surrounded by the blood and necessarily in equilibrium with it. Any great variation in the osmotic pressure of the blood would, therefore, be followed by a change in the content or concentration of every dependent cell. It appears to be a special function of the kidney, therefore, to eliminate just enough of the accumulated blood products to keep this mean osmotic pressure at its normal value. If in any given case a wide divergence from this is found by experiment, the conclusion is at once drawn that some serious impairment of the kidney has taken place. The test is easily made with a small amount of the blood by what is known as the cryoscopic method. Its diagnostic value is generally recognized.

Similarly, we have in the determination of electrical conductivity another simple method of finding a certain kind of solution content. This method may be applied to body fluids, especially to the urine and to the blood, and the information secured has often considerable value, since it is not exactly the same as may be obtained by the methods of chemical analysis. The general procedure has been applied in other kinds of work, twenty years or more, but only within the last four or five years have the applications in medicine been thought of. It will be recognized that these applications are comparable to new methods of analysis and their value must be measured from that standpoint.

But the chief value of physical chemistry to medicine does not lie in this direction, practical as it may appear. The development of the modern theory of solutions has wrought a most wonderful change in our mode of thinking of chemical problems, and while for a time this change was noticeable mainly in the treatment of questions of inorganic chemistry, it has finally appeared in the discussion of medical problems also. In pharmacology the conception of independent ions is a helpful one in explaining many points in the action of drugs which have hitherto been obscure. It is well known that the chemical activity of many substances in solution may be greatly modified by the presence of other substances having like ions free. Physiological activity, it is found, is often modified in the same manner, and beyond question the problem here presented will be found a fruitful one in the theory of medication and in the explanation of incompatibles. The importance of certain ions in the blood and in the muscular juices has just begun to be clearly recognized and the maintenance of these in right amount, even when only traces may be present, is a chemical necessity. It is known that the inorganic substances which yield ions have a necessary duty to perform in the body. The constancy of the one per cent. of mineral substances in the blood is doubtless more necessary than the constancy of the twenty per cent., or more, of organic substances.

The physical chemists have given us a number of new general methods of attacking old problems. Some of them have an important bearing on live questions in medicine. For example, take the question of the solubility of uric acid and the urates, the deposition of which in the tissues is supposed to be the source of many disorders. For fifty years or more much has been written on the problem of dissolving these urate deposits or concretions, or of preventing their formation. Lately several writers have begun to study this ever-interesting topic from the standpoint of the mass action law and dissociation hypothesis, and in a way which promises much for the clearing up of the fundamental conditions of deposition. It has already been pretty well shown why certain suggested remedies have not been of value and can not possibly do what was long claimed for them. In the uric acid problem two fundamental ques-

tions are involved; one of these has to do with its formation in metabolism. The other is a question of chemical equilibrium at a given temperature. The first question is the more difficult and also practically the less important. The second question may not prove difficult of solution.

I have spoken of the great work of Ehrlich and others in the development of the doctrines of immunity and toxicity. In the experimental examination of this problem it was found that many reactions between toxins and antitoxins can be carried out in the test-tube, leaving for the animal experiment certain final or crucial reactions only. In other words, a large number of important points in question seem to be strictly chemical and must be tested by chemical rather than by biological methods. In deciding on the nature of any given reaction taking place in solution and requiring time for its completion a determination of the so-called speed of the reaction is often of value. It has been shown that reactions taking place in one direction and involving one, two or three molecules follow certain definite schemes. The behavior of some of the simple ferments has been studied from this point of view and lately it has been found possible to submit the reaction between toxins and antitoxins to this kind of mathematical analysis. Something over a year ago Arrhenius and Madsen published a very important paper with the title: 'Applications of Physical Chemistry to the Study of the Toxins and Antitoxins,' in which, from the observations of Ehrlich, the essentially chemical nature of these reactions was shown. This paper was followed by others by the same authors and also by Ehrlich, who takes exception to some of the physico-chemical generalizations, yet recognizes the value of the mathematical treatment. It is likely that this discussion is but the beginning of the application of physical and mathematical chemistry in the exact study of problems which at one time were assumed to be essentially biological. I believe that medical science will derive great benefit from this alliance, as a means is here offered of testing the value of many assumed working hypotheses. There is a field here which is worthy of attention and which certainly can not remain long unoccupied. Many reactions taking place normally in the body will be found to lend themselves readily to the physico-chemical treatment and the applications in pathology will also appear as the methods become better understood.

Many medical men are beginning to recognize the value of this line of inquiry in the development of research, and the question is often asked how may the practitioner of medicine make himself familiar enough with the new physico-chemical theory to derive any benefit from it. This is admittedly a difficult question. With the student of medicine, however, the case is different. He may be given from the start the proper training to enable him to understand something of the drift of this new chemistry, if not to practise it readily. An opinion has been cultivated for years in some of our medical schools that the only part of chemistry really important for the physician is the organic chemistry of the food stuffs and their metabolic products. This is an extremely narrow conception of the case and it has often led to a neglect of those branches of general and physical chemistry through which the foundation principles of the science may be most satisfactorily presented. With the growing importance of the applications of physical chemistry in medicine the chemical training of the medical man will have to be correspondingly advanced, and of necessity the foundation work in this training will have to be done in the freshman and sophomore years of our scientific

schools and colleges, since few medical schools will have the equipment or be able to afford the time to do it properly. Physiological chemistry will become then a first-year study in all of our medical courses, and the young man beginning the study of medicine must bring with him a knowledge of general inorganic and organic chemistry sufficiently broad to enable him to grasp the new problems which medicine now presents.

J. H. Long.
Northwestern University, Chicago.

SCIENTIFIC BOOKS.

Handbuch der Fischkrankheiten. Von Dr. Bruno Hofer, Professor der Zoologie an der tierärztlichen Hochschule und Vorstand der Kgl. Bayer. Biol. Versuchsstation für Fischerei in München. Mit 18 Farbentafeln und 222 Text-Abbildungen. Verlag der Allg. Fischerei-Zeitung, München. 1904.

This is the first book devoted exclusively to the diseases of fishes, a volume of 359 pages well printed and well illustrated. The author asserts that the first aim of his work has been to aid the practical fish culturist and secondarily to gather together the substance of the few widely scattered scientific papers on the subject and his own unpublished material, the result of his observations as director of an experiment station. No technical knowledge is necessary to make use of the book. Particular diseases are described under the heads of external symptoms, course, cause, cure and prevention, the pathological changes receiving but passing notice. The scope of the work is limited to middle Europe and to fresh-water fishes alone, with Siebold's 'Die Süsswasserfische von Mitteleuropa' as a basis of nomenclature.

The book is divided into four sections. These treat of general infections, diseases of special organs, the crayfish disease, and general measures against fish diseases. Fourteen bacterial diseases are described, of which six are regarded as specific infections, and the characters of the organism are summarized. The disease itself is given a distinctive name, as 'furunculosis,' 'purpura cyprinorum,' 'pestis salmonis,' etc. The last is the widely known so-called fungous disease of salmon which engaged the interest of Huxley, who believed it to be caused by *Saprolegnia* alone. Dr. Hofer accepts the work of Patterson, who holds the fungus to be a secondary or terminal attack and describes '*Bacillus salmonis pestis*' as the primary cause. It is further interesting to note that the bacillus of tuberculosis is found in fishes, a form recognizably different from the parasite in man and not pathogenic for warm-blooded animals. Seven other organisms are found associated with disease, but their rôle is not regarded by the author as satisfactorily determined. Infections of fishes with bacteria and animal parasites are not unknown in this country, but serious epidemics due to them have been described only among domesticated fishes, while in Europe they seem to be more common and devastate alike the natural habitats as well as the ponds of breeders.

Two general infections with protozoan parasites are described, each caused by a myxosporidian of the genus *Myxobolus*. A systematic list is given, profusely illustrated and with a short characterization of each species, of the sporozoa parasitic for fishes, in which Gurley's U. S. Fish Commission paper is largely drawn upon. This plan of illustrated synopses of the species is carried out with each group of parasites, more extensively with the crustacea.

The second section occupies two thirds of the book and is taken up with local diseases. The skin affections receive most attention and its lesions are mainly caused by parasites, the most important being the saprolegnious fungi, the great enemy of domesticated fishes. None of the tissues or organs is without its pathologic affection. Even the nervous system is the seat of parasitism, the author himself having investigated a yet unnamed sporozoan which causes in trout 'taumelkrankheit,' a torpor finally ending in death. Other authors have described 'polyneuritis parasitica' due to a *Myxobolus,* and a parasitic worm. A short chapter is given to an unexplained exophthalmia, a symptom frequently seen as a

manifestation of, perhaps, several different causes, one of which is of considerable importance in this country and has been shown to consist in unusual amounts of dissolved air.

The third section is devoted entirely to the crayfish disease, 'Krebspest,' for years past widespread and destructive in Europe, but here unknown. The author and his assistant have made a special research on this subject and have described as the cause of the disease *Bacterium pestis astaci*, which attacks also, causing a general infection, several cyprinoids and allied fishes in the waters of nature as well as in domestication.

The last section consists of a few pages of general directions to the fish culturist with respect to measures to be taken at the onset of disease. In general there is little encouragement to the breeder in the way of remedies. Therapeutics with fishes is not far advanced and the prognosis in the case of the general infections is bad. Some cases of external parasitism may be successfully treated, but the chief reliance must be in prevention. Practical directions are given for the disinfection of ponds and the natural remedy is frequently advised of removing infected trout to rapidly flowing streams.

The book is profusely illustrated with colored plates, drawings and photographs, and to these it owes a large part of its usefulness. The representation in color of the lesions of the bacterial diseases aids their identification, which is rather difficult at best.

M. C. MARSH.

Katalog der Bibliothek der Gesellschaft für Erdkunde zu Berlin. Versuch einer systematik der geographischen Literatur. Von PAUL DINSE. Berlin, Ernst Siegfried Mittler und Sohn. 1903. Pp. xxvii + 925. Price, 12 Marks.

When the Berlin Gesellschaft für Erdkunde moved into its own building the opportunity was given for a rearrangement of its library. The scheme in use had become antiquated and inadequate. To Dr. Dinse was entrusted the preparation of a new plan of arrangement. The results of this work lie before us in this large and in every way satisfactory catalogue, which from its fullness and fine subject classification has high bibliographic value. The scheme of classification is close and thoroughgoing, yet based largely upon considerations of practical convenience. Two main divisions are adopted: general geographic literature and literature of single regions and the sea. Under the former are the subdivisions: (1) bibliography, (2) history of geography and discovery, (3) history of cartography, (4) methods and education, (5) encyclopedic literature of geography, (6) collections and miscellaneous writings relating to geography, (7) general physical geography, (8) general bio-geography, (9) general anthropo-geography, (10) geography of political and economic history of nations, (11) onomatology and transcription. These are again subdivided and when necessary or desirable re-subdivided, sometimes according to subjects and sometimes by countries. The second main division, literature of single regions, is subdivided by continents and countries, and when the literature pertaining to a country is very extensive, this is again subdivided by subjects. Periodicals are arranged separately by countries.

Among the admirable features the following may be noted. The names of authors, when known, and the titles of books, separates and periodicals are given without abbreviations. When doubt might arise as to where a paper should be placed, it is given in full in the two or more places where it might go. At the end of every entry is given, inconspicuously, the letter and number indication showing the exact location of the work in the library of the Gesellschaft. Under each subdivision the works are arranged in order of publication. An author index with abbreviated title and page reference enhances greatly the usefulness of the work which will prove almost as useful to geographic workers in general as to the members of the Berlin Gesellschaft für Erdkunde.

J. M. NICKLES.

SOCIETIES AND ACADEMIES.

THE CHEMICAL SOCIETY OF WASHINGTON.

THE 151st regular meeting of the Chemical Society of Washington was held on Thursday

evening, May 12, 1904, in the assembly hall of the Cosmos Club.

The first paper on the program, entitled 'Heat of Dissociation Proportional to Atomic Weight,' was presented by Dr. E. A. Hill. The paper was a synopsis of the author's dissertation presented to the Columbian University for the degree of doctor of philosophy.

The second paper on the program, entitled 'The Colloid Theory of Plasticity,' was presented by Allerton S. Cushman. The speaker reviewed briefly the evidence which has already been published by himself and other investigators, which tends to show that the two important useful qualities of clays, viz., plasticity and binding power, are caused by the presence of a certain proportion of colloid particles. To prove this, a large amount of evidence has been collected and artificial clay bodies have actually been synthetically prepared in the laboratory, possessing all the peculiar properties of natural clays.

Experiments were made on the lecture table which showed that the addition of certain reagents, such as tannic acid, alum and ammonia, to a pure kaolin clay profoundly modifies the properties and the relation of the clay body to water. Such reagents have no action on inert crystalline particles, but they do upon colloids, producing various effects, such as coagulations, flocculations and deflocculations. Curiously enough, all these reagents, as was shown by a simple experiment, increase the binding power of clay, either by deflocculation of the colloids already present or by producing reactions involving the formation of new colloids. Acheson has recently claimed and obtained a patent for increasing the binding power of clay by treatment with tannic acid. This process is called the Egyptianizing of clay on the, perhaps, somewhat fanciful theory that it was the tannic acids of the straw infusion rather than the fiber of the straw itself which gave strength to the low binding clays of ancient Egypt. From more recent work it is questionable whether small amounts of ammonia will not produce the desired effect even better than tannic acid at a much less expense, and in so simple a manner that its use can not be restricted by patents.

For the last fifty years occasional investigators have been noticing that clays and soils have the power of absorbing certain ingredients from solutions in which they are soaked, and further, that these absorptions are selective, certain substances being eagerly taken up and others rejected. If the clay is first heated to a certain point it no longer exhibits this power, showing that it is not due to adsorption on the particles. This again is a colloid property, and inorganic colloid precipitates made in the laboratory show the same peculiarity. Clays that have been treated with tannic acid and ammonia will absorb less water than the untreated clays and will, therefore, require less water to bring them to a desired consistency. Thus the danger of shrinkage and cracking on drying out is lessened. Attention was called to the importance of the study of these selective absorptions by clay bodies in the investigations of soil physics.

The third paper on the program was entitled 'Notes on the Methods of Detection of Sesame Oil,' and was presented by L. M. Tolman. A number of imported olive oils were found by the author that gave a marked reaction with the Baudouin or Villerecchia reagents.

The substance in these oils giving this reaction can be removed by alcohol so that the purified oil gives no color with these reagents. If Sesame oil is present the reaction is not decreased by this method of purification.

The fourth paper on the program, by Peter Fireman and E. G. Portner, on 'Some Observations on the Dissociation of Chlorides by Means of a Qualitative Test,' was presented by Dr. Fireman.

The last paper on the program for the evening was a 'Note on a Bibliography of Solubilities,' presented by A. Seidell. The author mentioned that the preparation of a bibliography of solutions had been begun about eighteen years ago by a committee appointed by the British Association for the Advancement of Science. This committee reported eight years later (1894) that they had collected all the references to work on solutions published prior to 1874 in the periodicals cata-

logued by the Royal Society. This collection has never been published, the manuscript being still in possession of Professor W. W. J. Nicol, the secretary of the committee. For this reason the author undertook the preparation of a bibliography of solubilities only for the years 1875 to 1903, inclusive, and for its compilation carefully examined the tables of contents or indices of twenty-six chemical journals and in addition gives references to papers contained in a great many other journals. Short abstracts enumerating the chemical substances employed in the work are given for each reference and at the end an indexed list of all chemical compounds which have been employed in solubility investigations is given.

At the conclusion of the formal program for the evening Dr. Wm. H. Seaman, of the Patent Office, exhibited and explained a new form of spirometer (small gasometer) which may be used for testing the lung capacity, analyzing air, measuring gases, etc.

A Correction.—At the request of Dr. Chas. Baskerville the following correction in the report of his lecture contained in the May 13 issue of SCIENCE, page 758, is made. He did not call 'especial attention to the observation that all minerals which have the property of becoming phosphorescent under the action of radium rays contain the element helium,' *but* that 'those minerals which are known to contain helium and are radio-active give off a gas or emanation when heated, which may be condensed by liquid air and exhibits the same properties of causing Sidal's blende to phosphoresce as do the emanations of radium compounds and thorium dioxide.'

A. SEIDELL,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 587th regular meeting was held on May 21, 1904, Vice-president Day in the chair.

A memorial address on the late Major J. W. Powell was read by Dr. W. H. Dall. A sketch of his life was given and some of his achievements; he was said to be far-seeing, much in advance of his time, as on Indian questions and irrigation; his predominant characteristics were courage, sympathy and insight.

Professor E. A. Pace, of the Catholic University, then spoke by invitation on 'The Rhythm in Visual Perception.' In the attempt to distinguish between physiological and (possible) physical phenomena the study of threshold phenomena may throw much light. So the fluctuations in the perception of a constant, just visible light have been studied. Various writers have attributed them to the afferent nerve, to the central organ, and to fatigue of the ciliary muscle. The speaker had disproved this last view in 1891 by the use of atropine. Later observers found the periodicity stands in close relation to vaso-motor activity and respiration. The speaker's recent observations, still incomplete, on after-images show that the fluctuations are due to retinal fatigue. The paper was discussed by the audience with reference to its bearings on observations on variable stars, and on the velocity of light by the Fizeau-Cornu method.

Mr. J. F. Hayford, of the Coast and Geodetic Survey, reported on 'A Test of the Transit Micrometer, as a Means of Eliminating Personal Equation.' In this instrument the observer attempts to keep the wire on the star, and the instants when the wire passes certain fixed positions are electrically recorded on the chronograph sheet. The practical result is that in difference-of-longitude work three nights' observations by the new method without change of observers are equal to ten nights with exchange by the old key method.

After some discussion the society adjourned till October 15.

CHARLES K. WEAD,
Secretary.

THE NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

THE regular meeting of the section was held on May 2 at the American Museum of Natural History. The program consisted of four papers, abstracts of which are as follows:

The Theory of a Double Suspension Pendulum: R. S. WOODWARD.

Professor Woodward described a double suspension pendulum apparatus for determining the acceleration of gravity and gave a brief outline of the theory of the apparatus. The latter consists of two rectangular bars of brass about twenty kilograms mass each, connected by two steel tapes of equal length in such a way that when one bar is held rigidly horizontal the other bar will be suspended horizontally by the equal and parallel tapes. It was shown that when the suspended bar vibrates longitudinally through small amplitudes its motion is very nearly the same as that of a simple pendulum whose length is equal to that of the tapes. It was shown also how small corrections due to the mass of the tapes and to their rigidity may be applied in order to get from the actual apparatus results in conformity with those of a simple pendulum.

Measurements of the Primary Feathers of Recently Killed Hawks, and their Bearings upon the Problem of Bird Flight: C. C. Trowbridge.

During the spring the author succeeded in obtaining a series of measurements of the primary feathers of the hawk's wings, immediately after the death of the birds, and secured additional proof of his theory that certain birds of prey habitually interlock their primary feathers in flight.

It was found that when hawks are examined immediately after they have been killed there usually appear deep depressions in the edge of the posterior webs of the emarginate primary feathers, where the feathers have been in contact, which are caused by the interlocking of the primaries.

The measurements consisted in determining the width of these depressions at short intervals of time immediately after the death of the hawks. It was found that the depressions gradually disappeared, both in cases where the feathers were found locked and were then unlocked, and in cases where the feathers were found unlocked. Data were thus obtained from which well-defined curves were constructed, showing the recovery of the web of the feathers after the pressure caused by the interlocking feathers was relieved. A number of life-size photographs were taken of the primary feathers immediately after the hawks were killed and the photographs of the depressions in the feathers when measured by a Repsold measuring machine, gave curves which agreed very well with those obtained by direct measurement. Similar curves were obtained by artificially interlocking the primaries for several hours and then measuring the recovery of the web of the feathers with a micrometer microscope. It was found that artificial locking of the feathers for ten minutes produced very slight or no depressions and locking them for several hours produced depressions only about one half as deep as those found when the hawks were killed. In the latter case they were from 2 to 3.5 millimeters deep, and required from one to five hours to be reduced to twenty per cent. of the original depth, the rate of change of the depth of depression being most rapid at first.

It was concluded from the measurements and photographs that the primary feathers found with the depressions in the web had been interlocked several hours or more previous to the death of the hawks, which were killed while sailing in a strong wind, and that the theory of interlocking of the primaries of the wing in flight had been conclusively confirmed.

The Generation of Electrical Charges by Radium: George B. Pegram.

Dr. Pegram's paper related to the generation of electrical charges by radium, with special reference to the suggestion of Soddy that when the α particles, carrying their positive charge, are expelled from the radium, there is no corresponding negative charge left behind in the mass. A few milligrams of radium bromide were enclosed in a thick lead capsule, which was supported on a quartz rod in an exhausted vessel. Gold leaves attached to this capsule gave no indication of a charge, showing either that there was the usual generation of equal amounts of positive and negative electricity when the α particles are thrown off, if, as has been supposed, the number of α particles is much greater than the number of negatively charged particles, or else that the number of β particles is about equal to the number of α particles. It remains to try a similar experi-

ment with radium bromide which has been recently in solution, and, therefore, sends off few of the β particles.

Bending Moments in Rails, for the Same Superstructure, under Different Types of Locomotives: P. H. DUDLEY.

In previous communications to the academy, the author presented from stremmatograph tests, tabulations of the recorded unit fiber stresses in the base of rails, and their distribution under moving locomotives and cars.

The determination from the unit fiber strains, of the negative and positive bending moments of the rails, due to the passing wheel effects, indicates that for a definite construction of the superstructure of the permanent way, they are independent, partially, of the total load of the locomotive or car, but dependent upon the type of each, in construction of wheel base and wheel spacing, in loading the foundation.

In a series of stremmatograph tests, on the New York Central and Hudson River Railroad, near mile post No. 10, December 23 and 30, 1899, locomotive No. 870, an eight-wheel type of engine, weight 220,000 pounds, drawing the 'Empire State Express' of four cars, weight 430,000 pounds, at speeds of 42 and 44 miles per hour, the average positive bending moments for the engine were 12.40 inch-pounds, per pound of static load, for one rail, constrained by a negative bending moment of 1.88 inch-pounds.

The average positive bending moments for the entire locomotive were 11.48 inch-pounds, per pound of static load, constrained by a negative bending moment of 1.71 inch-pounds.

On December 30 locomotive No. 2032, a ten-wheel type of engine, with closer wheel spacing, weighing 283,900 pounds, drawing the 'Southwestern Limited' of ten cars weighing 910,000 pounds, at a speed of 40 miles per hour, at the same place as the preceding tests, the positive bending moment for the engine was 10.80 inch-pounds per pound of static load, for one rail, constrained by a negative bending moment of 2.18 inch-pounds—a more favorable result than for the eight-wheel type.

For the entire locomotive, the positive bending moment—for normal tender wheels—was 9.82 inch-pounds, for one rail, constrained by a negative bending moment of 1.90 inch-pounds, indicating a more favorable loading of the foundation. The bending moments of different types of locomotives on the same superstructure are a measure of the relative efficiency of the distribution of their loads to the foundation; while with the same type of engine the relative efficiency of the construction of the superstructure of the permanent way can be measured. These are first bending moments measured in rails under moving locomotives and cars.

Dr. H. G. Pifford exhibited an electrometer specially designed for use in measuring radioactivity and showed the action of the instrument by lantern projection.

C. C. TROWBRIDGE,
Secretary.

DISCUSSION AND CORRESPONDENCE.

APPENDICITIS AND THE RACE.

IN the possible effects upon the race of surgical intervention as a cure for disease we have a curious anomaly; nothing less in fact than the direct contradiction of the general proposition which is at the basis of the law of the survival of the fittest, viz., that what is good for the individual is good for the race. Some have questioned the validity of this so far as its application to certain phases of our social and institutional life is concerned, but I have yet to learn of any serious doubt having been cast upon it in its bearing upon the organic evolution of animal forms under natural conditions. Yet under the artificial condition of the removal of diseased parts in order that the life of the individual may be prolonged we have precisely this. In order to give the discussion concreteness let us consider the possible racial effects of the now common operation for appendicitis. Since the old theory of foreign lodgments—grape stones and the like—in the appendix as the cause of the trouble has been proven false, at least in a vast majority of cases, we are forced to consider appendicitis a disease; an inflammation of a particularly serious nature, yet no more accidental in its origin than are similar congestions in other parts of the body. But

scientists tell us that diseases of all sorts—at least the predisposition to them—are transmissible; that they run in families, and that the probability is greater that the children of diseased parents will fall heir to the particular maladies of the latter than that the children of unaffected parents will be troubled by them. It is true that in the case of appendicitis, recent acquisition as it is to the catalogue of bodily ills, we have no exact data in support of the belief that it is transmissible, yet reasoning from analogy we have every right to believe that it is so. A hereditary predisposition to many other forms of inflammation similar in all respects except that of the part affected has been fully demonstrated and the inference is certainly a logical one that appendicitis is no exception to the rule.

But under the conditions of nature, such a transmission of disastrous predispositions is taken care of through the early death of the individual with the consequent impossibility of passing them to the descendants. If death comes before the period of maturity is reached the lack of offspring means the total annihilation so far as the race is concerned, of disastrous consequence in that particular line of descent. If it comes early in maturity such annihilation is not absolute but only relative, the danger to the race increasing with the length of life as measured by the number of children. In any event nature demands death without offspring on the part of the individuals possessing racially disastrous predispositions. Yet that is what the prolongation of life through surgical intervention controverts. All danger of death from the particular diseased part, so far as the individual is concerned, is removed without lessening seemingly one whit its disastrous effects upon the race. A long life is assured so far as the particular disease is concerned and, all other things equal, a correspondingly large family with all the laws of heredity potent, so far as the probable transmission of the difficulty is concerned. To believe that the surgical removal of the diseased part does away with the probability of the transmittal of the disease would be to accept the theory of the transmission of mutilations. This, few thinking persons, familiar with the field of scientific thought, are willing to do. Generations of artificially misshapen heads among certain savage tribes, of the mutilated feet of the Chinese women without racial effect, to say nothing of the lack of results of century upon century of circumcision, are all in opposition to it. And the corollary is that the good offices of the surgeon—whom, by the way, we shall probably continue to patronize in spite of any disaster we may see impending future generations—are the surest means of making permanent his calling. That this is true in the case of appendicitis is more easily seen than for other surgically prevented diseases, for we can not doubt that nature, left to herself, would in time eliminate the vermiform appendix altogether with the consequently disastrous results to the surgeon's income. We need not, however, impute to him any sordid motives when we say that he is taking the surest means of preventing such a catastrophe.

Edwin G. Dexter.
The University of Illinois.

'THE TREE-DWELLERS.'

To the Editor of Science: Since the two articles which have appeared in recent numbers of Science regarding 'The Tree-dwellers' contain several statements not supported by facts, and since the criticisms made rest largely upon a hypothetical basis, it may not be out of place to call attention to the same through the columns of the paper in which the articles appeared. The articles referred to are a letter from Dr. E. C. Case, State Normal School, Milwaukee, Wis., published in Science, April 1, and an article by Dr. Theo Gill, entitled "'Horses' not Horses," appearing May 6.

At the outset I wish to acknowledge an indebtedness to Dr. Case, for it was his criticism which first called my attention to the possibility of making the startling interpretation which he makes of the illustration on page 67, which he refers to as a Jurassic dinosaur chasing an Eocene horse, and the illustration on page 62 which he refers to as 'a man in a tree watching a herd of the same horses (?) that were pursued by the Jurassic dinosaur!' Dr. Case continues, 'This makes

man contemporaneous with the dinosaur, although it is not so stated in the text.'

The attempt to avoid many words unfamiliar to children led to the use of the term 'horse' on pages 66 and 67 where 'mammal' or 'ancestor of the horse' would have been more exact. The lesson in question was intended merely to give some such general conception as Professor N. S. Shaler gives in his chapter on the horse in 'Domesticated Animals,' pages 58–9, where he states: "In the first stages of the Tertiary period, in the age when we began to trace the evolution of the suck-giving animals above the lowly grade in which the kangaroos and opossums belong, we find the ancestors of our mammalian series all characterized by rather weakly organized limbs fitted, as were those of their remote kindred, the marsupials, for tree-climbing, rather than for running over the surface of the ground. *The fact is that all the creatures of the great clan acquired their properties of body in arboreal life, and with such relatively small and light bodies as were fitted for tree-climbing.*"

In so far as the illustration on page 67 conveys the idea that the remote ancestors of the horse and other mammals once lived in proximity to dinosaurs and were preyed upon by these creatures, it is true to the facts. Its defects consist in the fact (1) that the form of the mammal in question resembles too closely that of the Eocene horse, and (2) the hind limbs of the dinosaur are not as long as the skeletons indicate.

Although the dinosaur in question lived in the Jurassic period, as Dr. Case states, carnivorous dinosaurs were abundant in the Cretaceous and did not become extinct until the end of that period. When this fact is taken into account, and when it is remembered that the most eminent paleontologists still expect to find in the Cretaceous rocks forms intermediate between the Jurassic mammals and the Eocene types, the reader can better appreciate the point of view of the author in presenting the lesson as it appears in the first edition. But the illustration is defective and it will not appear in the second edition. The two lessons on the wild horse, including the remote ancestors of the horse, have been revised, and although the ideas used are substantially the same, it is hoped that they are expressed in a form which will not offend the genuine student of science. It must be remembered, however, that the nature of the work precludes the use of technical terms.

The horses represented in the illustration on page 62 are intended for Pleistocene horses and are briefly described at the foot of page 70 and on page 71. It may be due to the stripes, which are hypothetical, and to his interpretation of the perspective of the picture, that have led Dr. Case to interpret the horses as Eocene forms. Although this picture is not incorrect, it will be replaced by one which can not be interpreted in such a way.

Had Dr. Case read the text more carefully he might still be in doubt regarding the time relations of the dinosaur and the ancestors of the horse on account of my use of the term 'horse' on pages 66 and 67. But he surely could not have failed to see that man's relation to these primitive forms is distinctly stated, even though technical terms are avoided. For instance, the first line of the text quoted by Dr. Case should make clear that the animal described in the following lines lived long before man appeared. Again, at the foot of page 70 and the top of page 71 the form of the horse which was contemporaneous with man of the mid-Pleistocene period is clearly stated. Had this not been sufficient, Dr. Case could have found two notes of warning against such an interpretation as he has made, on pages 146 and 154.

The real evidence, then, upon which the criticisms of Dr. Case thus far considered rest, is this: The defects pointed out in the illustration on page 67, and the use of the term 'horse' in a sense wide enough to include the remote ancestors of the horse. The evidence which he has neglected is *the text itself*.

In view of the well-established and readily available statements concerning the discoveries of Professor Cope in the United States, and Professor Boyd Dawkins in Europe, with reference to the hairy mammoth and the sabre-toothed *Felis* (*Machairodus*), it is difficult to understand how Dr. Case could venture the

criticism, 'This book is filled with just such mistakes throughout, notably a figure of a sabre-toothed tiger in fierce combat with a hairy mammoth.' Near the town of Hennessey, Oklahoma, Professor Cope obtained teeth and bones of the mammoth associated with the bones of a sabre-toothed cat as large as a lion, as though 'death had overtaken it while feeding upon the carcass of the mammoth' (*J. Acad. of Nat. Sci.*, Phil., IX., page 453.) It is doubtless unnecessary to state that the illustration will stand as an accurate portrayal of a combat which man of the mid-Pleistocene period undoubtedly witnessed many a time.

Since Dr. Gill's criticisms appear to be based upon the statements made in Dr. Case's letter and not upon an examination of the book at first hand, they need little attention. There are a few statements, however, which the reader may be interested in comparing with statements of other eminent scientists.

Dr. Gill states, 'But no ungulate in the line of the horse with five toes has been discovered.' Professor Cope writes ('Origin of the Fittest,' page 301): "*Phenacodus* is antecedent to all the horse series, the elephant series, the hog, the rhinoceros and all other series of hoofed animals. It has five toes on all of the feet."

Again Dr. Gill writes: 'Another pure assumption is that the primitive equoidean animals lived especially in the marshes.' Professor Huxley in his American Addresses, refers to the Eocene horses as 'the short-legged, splay-footed plodders of the Eocene marshes.' Professor Cope writes ('Origin of the Fittest,' page 374): "* * * the types with reduced digits are dwellers on dry land in both orders, and those that have more digits are inhabitants of swamps and mud. * * * Certain it is that the lengths of the bones of the feet of the ungulate orders have a direct relation to the dryness of the ground they inhabit, and the possibility of speed which their habitat permits them, or necessarily imposes on them." (See, also, Mr. Lucas's statement, *McClure's Magazine*, volume 15, page 517.)

Still again Dr. Gill writes, 'But there is no need of confining such animals to the marshes.' Had Dr. Gill read the next few pages of the text he would have been spared the trouble of making the remark.

Dr. Gill is certainly correct in stating, 'Every instructed zoologist would know that such a characteristic as five toes (or four) must necessarily be coordinate with innumerable modifications of other parts,' but one can scarcely be expected to present all of 'these innumerable modifications' to the child of seven years. In presenting a brief account of the changes that took place in the feet and in reserving the changes in the structure of the teeth for a later period, I find support in the statement of Professor Cope ('Origin of the Fittest,' page 269), where he states, "The primary forms of mammalia repose in great measure on the structure of the feet. Those of the teeth are also significant, but present a greater number of variations among animals otherwise nearly related."

While not a specialist in paleontology or in several of the sciences to which I find it necessary to go for materials, I have taken great pains to secure reliable data, and to consult with specialists concerning the same. Since Dr. Case's criticism was made, Dr. S. W. Williston, professor of paleontology of the University of Chicago, has kindly examined 'The Tree-dwellers' from the point of view of the paleontologist; and he has given me permission to state this fact in this letter and in the preface to the second edition of the book. In view of the fact that Dr. Case states that the book is filled with glaring errors, the reader may be interested in knowing that Professor Williston has authorized me to state that aside from the changes made in the lesson on the wild horse referred to above, the changes he suggests are few and unimportant.

It is too much to expect a series of books which represents such a radical departure from traditional text-books for children as this series does, to pass unchallenged. But this is not a matter to be regretted. That which causes one to review one's work, to weigh evidence more carefully, to eliminate errors, to reconstruct in the light of a higher truth, should be welcomed by all. A careful examination and criticism of the series is invited, with the assurance that the points which

are brought to the attention of the author will receive due consideration.

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SPECIAL ARTICLES.

MONT PELÉ FROM OCTOBER 20, 1903, TO MAY 20, 1904.

THE publication in the daily papers of the statement that Mt. Pelé had celebrated the second anniversary of the destruction of St. Pierre by a heavy eruption, has renewed popular interest in the volcano. A few days before the appearance of this item, the author received, from a correspondent in Dominica, information that Mt. Pelé had been in serious eruption on May 8 and had blown out the new central cone. Inquiry at the office of the American Trading Co. in this city elicited the statement that letters from their representative in Martinique, under date of May 11, made no mention of the volcano, which would hardly have been the case had there been a great eruption.

To-day copies of the *Journal Officiel de la Martinique* for May 10 to 20 have come to hand and the following quotation (translation) of the 'Bulletins concernant le volcan' will be of interest:

May 4 to 6, 1904.—Mountain almost constantly covered. Discharge of vapor moderate. A few rather heavy rumblings from time to time. Some shattering was produced at the top of the dome. The height has slightly diminished.

May 6 to 8, 1904.—Mountain constantly covered. Discharge of vapors very feeble Saturday morning, becoming rather abundant Saturday evening and Sunday (8th). Several discharges (flows) accompanied by rather heavy rumbling.

May 8 to 9, 1904.—Mountain remained constantly covered. Discharge of vapor rather abundant.

May 9 to 10, 1904.—The mountain which was covered in the morning, became clear after five o'clock in the afternoon. Moderate discharge of white vapors. Several rumblings. The summit of the dome has risen about five meters since April 26.

May 11 to 12, 1904.—Mountain covered during the day and free from clouds at night. Moderate discharge of white vapors. Frequent rumblings. Yesterday evening from 5:30 to 6 o'clock outbursts of rather thick red clouds to slight elevations succeeded one another almost without interruption from the southeast side. At 7:45 a rather bright luminous point appeared near the middle of the dome.

May 12 to 13, 1904.—Mountain clear in the afternoon. Rather abundant discharge of white vapors mixed with red vapors. Several rumblings, one of which was very heavy, yesterday at 10:25 P.M.

May 13 to 15, 1904.—Mountain almost constantly covered Saturday and uncovered yesterday. Several low outbursts of red cloud. Many rumblings. Moderate discharge of vapors. Yesterday morning at 9:50 a dust-flow of slight extent descended slowly as far as the base of the talus of débris.

May 17 to 18, 1904.—Mountain almost constantly covered. Some flows and rumblings Monday. Nothing noteworthy yesterday.

May 18 to 19, 1904.—Mountain constantly covered. Nothing to note.

(Signed) PERNEY.

Since October 19, 1903,* the history of Mont Pelé has not been characterized by any very startling events. The dome which has formed the summit of the mountain since the famous spine or obelisk was destroyed in August, 1903, has suffered many minor changes in altitude and form which have altered its appearance entirely from what it was at the beginning.

The history of the dome, as gathered from the *Journal Officiel*, is as follows:

October 21, 1903.—Loss of 5 m.

October 22.—Loss of 3 m.

October 25.—Slight modifications.

October 26.—Additional modifications.

October 29.—The dome has suffered certain changes; its height has been stationary for several days.

November 3.—The dome has suffered certain modifications of form without change in altitude.

November 5.—A considerable portion of the dome was blown off at 11:34 A.M.

November 8.—The dome rose 4 m. between the 6th and 8th.

November 10.—The dome seems to be destined to rapid disappearance on account of successive outbursts on the southwestern side.

* See Hovey, 'Mont Pelé from May to October, 1903,' SCIENCE, N. S., Volume XVIII., p. 633, November 13, 1903.

November 11.—A needle, 15 m. in height, which existed on the western part of the summit of the dome, has disappeared.

November 15.—The dome has suffered rather extensive changes.

November 16.—The summit of the dome has undergone additional modifications.

November 22.—At 8:30 A.M. an outburst destroyed a noteworthy portion of the dome.

November 27.—Loss of 3 m. in altitude.

November 29.—Additional modifications of the dome reported.

December 2.—The dome has suffered important changes and has lost through outbursts 10 m. of altitude.

December 10.—A large mass was blown off from the eastern side of the dome.

December 11.—Loss of 8 m. in altitude.

December 13.—Additional changes on the eastern side.

December 17.—Certain changes of form.

December 27.—Slight modifications noted.

December 31.—Loss of 3 m. since the 26th.

January 3, 1904.—The dome has undergone many changes. The remains of the ancient spine rise rather rapidly while the other parts of the dome, which seem stationary, are reduced by almost continual avalanches.

January 7.—A part of the dome has risen 3 m. since the 2d.

January 8.—Rise of 3 m.

January 12.—Slight modifications without change of altitude.

February 3.—Slight modifications.

February 25.—Modifications of form without change of altitude.

February 28.—A large mass fell.

March 6.—Loss of 3 m. in altitude since January 25. The southern portion of the dome is reported partly destroyed.

March 13.—The altitude of the dome is reported stationary.

March 17.—Sensible modifications noted.

March 27.—Gain of 3 m. since the 18th.

March 29.—Some modifications of form without change of altitude.

April 3.—Rise of 3 m. since March 27.

April 15.—The summit of the dome has risen about 5 m. since April 3.

April 20.—Rise of 3 m. noted.

April 25.—The summit of the dome has risen about 5 m. since April 20.

May 6.—Slight loss of altitude.

May 10.—Rise of 5 m. since April 25.

May 20.—Gain of about 5 m. since May 10.

Summarizing the foregoing notes, there was a continual loss of altitude of the dome from October 19 to December 31 inclusive, with the exception of three days in November when the dome rose 4 m. The net loss of altitude in this period appears to have been about 28 m. The daily bulletins are unsatisfactory in that 'modifications' are noted from time to time without any statement as to their character.

On January 3, Professor Giraud reports the important fact that the remains of the great obelisk which towered above the volcano in the early part of 1903, were again rising with reference to the remainder of the new cone. The daily reports from that time on say nothing further, however, with regard to the spine. A period of elevation set in with the beginning of January, 1904, with a rise of 6 m. during the first eight days of the year. Then for eleven weeks, the altitude remained stationary, except for a loss of 3 m. during the first week in March. With the 27th of March, the rise seems to have become nearly continuous and amounted to 29 m. in eight weeks (to May 20), giving a net gain of 32 m. since January first.

Whether this applies to the summit of the new spine which was reported rising early in January or not, the losses which took place in the altitude of the mountain during the last months of 1903 were regained during the first five months of the present year.

The activity of the volcano, which was so great during September, 1903, as to seem to threaten a first-class eruption, gradually diminished during the last quarter of the year, and there have been apparently few noteworthy outbursts to chronicle during the past four or five months. Few days, however, pass without clouds of steam rising from the crater, accompanied from time to time by dust-flows down the gorge to the Rivière Blanche to the southwest or across the basin of the Lac des Palmistes to the east.

Edmund Otis Hovey.
American Museum of Natural History,
New York, June 11, 1904.

THE OCCURRENCE OF TAURIN IN INVERTEBRATE MUSCLE.

A RECENTLY published paper by Agnes Kelly* on the occurrence of taurin in *Pecten opercularis* and *Mytilus edulis*, leads me to announce a similar observation on the occurrence of taurin among the muscle-extractives of *Sycotypus canaliculatus* and *Fulgur carica*, the zinc-bearing gastropods of Long Island Sound.†

Taurin has been described as a constituent of invertebrate muscle since 1845, when Karsten isolated a crystalline body from the watery extracts of certain molluscs, and identified it with the taurin separated from bile. Since that time the list has been largely extended by Krukenberg and others, until it includes the following molluscs: *Doriopsis, Turbo, Cassidaria, Mytilus, Ostræa, Pinna, Arca, Spondylus, Pectunculus, Pecten, Murex, Octopus, Loligo* and *Sepia*.

In a physiological-chemical study of various molluscs, which has been in progress in this laboratory for some time, under the direction of Dr. Mendel, taurin was separated in its characteristic crystal form, which, together with its sulphur content and chemical reactions, left no doubt in regard to its identity. This was further established by an analysis, which gave the following results:

	N.	S.
Calculated for $NH_2.CH_2.CH_2.SO_3H$	11.22%	25.62%
Found	11.37%	25.89%

Taurin has also been obtained from the muscles of *Haliotis*, the 'abalone' of the Pacific coast, by Professors L. B. Mendel and M. E. Jaffa, and likewise identified by analysis.

The finding of taurin—amido-ethyl-sulphonic acid—among the products of muscle katabolism in invertebrates is of particular physiological interest in view of the close relationship which has recently been shown to exist between taurin, cystin and the proteids.‡

The apparent association of taurin and glycocoll—amido-acetic acid—in molluscs, recalls the related occurrence of derivatives of these compounds in higher organisms.

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* Agnes Kelly, 'Hofmeister's Beiträge zur chemischen Physiologie,' V., p. 377, 1904.

† Cf. SCIENCE, Vol. XIX., No. 474, January 29, 1904.

‡ Friedmann, 'Ergebnisse der Physiologie,' 1902–3, I., 1, and II., 1.

THE PTERIDOSPERMAPHYTA.

SUCH is the name that I would propose to give to those plants, long extinct though they may all be, having the general character of Pteridophyta, but bearing seeds as in the Spermatophyta.* Such forms are now rapidly coming to light and are too well known to botanists to require enumeration. The name Cycadofilices which has been applied to them seems objectionable in several respects. While most of them do partake of the nature of both cycads and ferns, it is not certain that all do so, and additional ones may not entirely justify this designation. It is probable that they may, if some already known do not now, show affinities with the Pinales as well as with the Cycadales, and it is not at all improbable either that calamarian forms will be found with true seed vessels. A name is needed that shall express the broader fact that the ancient Pteridophytes occasionally developed so far in their reproductive system that they take on the characters of Spermatophytes. The term Pteridospermaphyta expresses this truth. It is somewhat long, but not longer than a number of the terms used in current systems of classification for which there are far less cogent reasons. It has the further advantage of denoting the true order or direction of development, and not the inverted order denoted by the term Cycadofilices.

The Pteridospermaphyta constitute a *phylum* coordinate with the Pteridophyta and Spermatophyta. They mark the progress of plant development from the standpoint of the reproductive organs. It is true that they bridge over a great chasm hitherto supposed to be impassable, but this is what we ought to expect as the knowledge of nature increases.

* This term is shortened by some writers to Spermaphyta.

Just as the discovery of the exogenous structure in many Carboniferous Pteridophytes (*Calamites, Stigmaria, Sigillaria,* even *Lepidodendron*) overthrew the old Lindleyan classification into endogens and exogens, which was supposed to be fundamental, so the discovery of the Pteridospermaphyta causes the later classification into spore-bearing and seed-bearing plants, which was confidently believed to constitute a durable substitute, to break down, and we are in the presence of the important truth that in both their internal structure and their floral structure the early types of vegetation advanced during Paleozoic time to a position not essentially different from that of the more developed types of the present day.

LESTER F. WARD.

INFLUENCE OF BORIC ACID AND BORAX ON DIGESTION AND HEALTH.

BULLETIN No. 84 of the Bureau of Chemistry, now in press, is the first of a series of monographs from that bureau embodying investigations made in accordance with the following authority contained in the act of Congress making appropriations for the Department of Agriculture, to wit: "To enable the Secretary of Agriculture to investigate the character of food preservatives, coloring matters, and other substances added to foods, to determine their relation to digestion and health, and to establish the principles which should guide their use."

These investigations were commenced in the autumn of 1902 under the direction of Dr. H. W. Wiley. Previous to their beginning a careful study of similar work done in this and other countries was undertaken and some of the laboratories where this work had been carried on, notably the laboratory of the Imperial Board of Health of Germany, at Charlottenburg, were visited and the method of experiments investigated. The plan finally decided upon was to secure the voluntary services of a number of young men who would undertake to try the effect of the added substances upon their digestion and health, to make the necessary observations, and to submit themselves to the rigid analytical control which such a series of investigations required.

The number finally selected for experiment was 12, as this was found to be about the maximum number which could be cared for with the analytical and culinary facilities afforded by the Bureau of Chemistry. A kitchen and a dining room were fitted up in the basement of the bureau and in December, 1902, the actual experimental work began and it continued, in the case of boric acid and borax, until July 1, 1903. The work was so divided that no one of the young men under observation was required to submit himself to the rigid control necessary to the conduct of the work more than one half of the time. The men selected were taken partly from the force of the Bureau of Chemistry and the rest from other Divisions and Bureaus of the Department of Agriculture. Each one was required to subscribe to a pledge to obey all the rules and regulations prescribed, and to abstain from all food and drink during the period of observation save that which was given him in the course of the experiment. Careful medical inspection of each of the members of the experimental class was secured, both directly and by collaboration with the Public Health and Marine Hospital Service. The details of the work, both analytical and medical, are found in full in the bulletin above mentioned which is now in press. Some of the conclusions are as follows:

When boric acid or borax equivalent thereto, in small quantities not exceeding a half gram per day, is given in the food no notable effects are immediately produced. If, however, these small doses be continued for a long while, as for instance in one case 50 days, there are occasional periods of loss of appetite, bad feeling, fulness in the head, and distress in the stomach. These symptoms, however, are not developed in every person within the time covered by the experiment, for some are far more sensitive to the action of these bodies in small quantities than others.

When boric acid, or borax in equivalent quantities, is given in larger and increasing doses there is a tendency to the somewhat rapid development in a more accentuated form of the symptoms above described. The most common symptom developed is a persistent

headache, a sense of fulness in the head, with a clouding to a slight extent of the mental processes. When the doses are increased to 3 grams a day these symptoms are established in a majority of the cases but not in every case. They are also sometimes attended by a very distinct feeling of nausea and occasionally by vomiting, though the latter act is rarely established. There is a general feeling of discomfort, however, in almost every case, but the quantities required to establish these symptoms vary greatly with different individuals. In some cases very large quantities may be taken without the establishment of marked symptoms, while in other cases from 1 to 2 grams per day serve to produce in a short time feelings of discomfort and distress.

No conclusions were reached in regard to smaller quantities than half a gram per day of the preservative, and, therefore, any statements in regard to the administration of smaller quantities must be based largely upon the results obtained with the quantities actually employed. It is reasonable to infer that bodies of this kind not natural to nor necessary in foods which exert a marked injurious effect, when used in large quantities for short periods of time, would have a tendency to produce an injurious effect when used in small quantities for a long time. The general course of reasoning, therefore, would seem to indicate that it is not advisable to use borax in those articles of food intended for common and continuous use. When placed in food products which are used occasionally and in small quantities it seems only right, in view of the above summary of facts, to require that the quantity and character of the preservative, that is, whether borax or boric acid, be plainly marked so that the consumer may understand the nature of the food he is eating.

*LABORATORIES FOR BOTANICAL RESEARCH.**

THE publicity given to the opening ceremonials of the new science laboratories at Cambridge by the king and queen on March 1 will, it may be hoped, do something to rouse those who are responsible for the welfare of the nation to a wider sense of their duties. The time has surely passed when the remarks of a well-known prelate and of a prime minister, to the effect that they were born in a pre-scientific era, could be received, if not with overt applause, at least with sneaking sympathy.

Sluggish as we are, some progress has been made. Up to the middle of the last century, and for some time after, there was scarcely a botanical laboratory properly so called in the whole country. Now we have the Jodrell Laboratory at Kew, a very modest institution when compared with the necessities of the case or to the excellent equipment of other departments of this great national establishment. The Jodrell Laboratory is not intended for instructional purposes, but chiefly for study and research, and much good work has been done there.

At Cambridge, Edinburgh, Glasgow, Dublin, at University College, London, the Royal College of Science, and in many other universities, agricultural colleges and technical institutes, there are now more or less well-equipped laboratories under competent direction. But these are mainly for the instruction of students. Research laboratories are still rare, and those willing and competent to utilize them are also few in number. This condition of affairs is largely due to the indifference and lack of encouragement on the part of those who ought to know better. The *cui bono* question is ever in their minds, and much too frequently on their lips. Abstract science does not appeal to their sympathies, or to their intelligence, unless some immediate practical result at once comes into view. When that happens the commercial instinct may perchance be aroused, and they begin to ask, will it pay? Of course, no reader of this journal is likely to undervalue abstract science, and most of them are well aware of the enormous value of the practical results that may and do result from it. But even such persons must have been startled to find how the observations of Bower and others on the minute anatomy of the prothallus and spore-producing tissues of ferns, observations which might have been thought to be too abstruse and recondite to be of any practical value whatever, have directly led up to the

* From *Nature*.

extremely important researches of Farmer and his associates into the essential nature of cancer!

Satisfactory as this undoubtedly is, we have only to look across the channel to see how puny—numerically and financially speaking—are our efforts to promote original research. Our cousins across the Atlantic, a practical people if ever there was one, are even more energetic. Does a 'freeze' destroy or seriously injure the oranges of Florida, what matter? In a very short time a man of science and a man of resource is on the spot. He looks for and finds a hardy stock whereon to graft the tender scion, he puts the resources of hybridization to the test in the endeavor to procure hardy seedlings. All this is done at once by state or government agency. Here, if anything were tried in a parallel case, it would be with great deliberation and with little or no encouragement or support.

Those familiar with what is done to promote research in the universities and colleges of the United States, as at New York, Chicago, Philadelphia and in California, not to mention the older foundations of Harvard and Yale, must feel almost aghast at the progress that is being made, and at our own backwardness. In the *Gardeners' Chronicle* for January 30 is an article contributed by a well-known professor familiar with what is being done here as well as there. In that article he gives details as to the astonishing activity manifested in the American universities, mainly by the aid of funds provided by private individuals. We too have reason to know and appreciate what is done by the government agricultural department, and by the very numerous experimental stations scattered all over the wide territories of the United States.

As we write, there comes to us a report of the establishment, under the auspices of the Carnegie Institution, of a 'desert botanical laboratory, the purpose of such establishment being to study thoroughly the relation of plants to an arid climate and to substrata of unusual composition.' A laboratory has accordingly been erected near Tucson, in Arizona, under the management of Dr. W. A. Cannon, of the New York Botanical Garden, who has been appointed resident investigator in charge of the laboratory. What may be described as a sort of preliminary report has been drawn up by Mr. Coville and Dr. MacDougal, and a very interesting and copiously illustrated report it is.

As some of our readers may care to see this publication, we may add that it is issued by the Carnegie Institution of Washington, U. S. A. (publication No. 6).

Vast as is their territory, and numerous as are their experimental stations and like institutions, our cousins are not yet satisfied. They have invaded British territory, in a most genial and friendly manner it is true, but still they have annexed, with our consent, a portion of the island of Jamaica, and there they have established, at 'Cinchona,' a botanical laboratory and research station open to the students of all countries. The direction is in the hands of Dr. Britton, of the New York Botanical Garden, in cooperation with Mr. Fawcett, the director of public gardens and plantations in the island. The policy of the 'open door' pursued by the Americans in these matters prevents us from doing anything but acquiesce in their proceedings. But why what should have been a plain duty for us should have been allowed to be undertaken by others is a mystery.

We do not question the utility of ironclads and cruisers as protectors of our commerce, but it is obvious to those who are watching the proceedings of our neighbors and of our rivals that if we do not largely extend our scientific training and induce our wealthy citizens to follow the example of their American brethren in endowing science, the necessity for protection will vanish, and that not slowly.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

The International Council met on Monday, May 23, and Tuesday, May 24, 1904, at the Rooms of the Royal Society of London, and transacted business as follows:

On the motion of Dr. Uhlworm, Professor H. E. Armstrong was elected chairman of the meeting and Dr. H. Forster Morley secretary.

On the motion of Dr. Blanford, it was resolved: That the report submitted by the executive committee be received and adopted for presentation to the Regional Bureaus.

The council authorized the distribution of the balance sheet to the several regional bureaus for publication in some recognized periodical in each of the constituent regions, in accordance with the regulation laid down at the Third International Conference.

On the motion of the chairman, it was resolved: That, in view of the success already achieved by the International Catalogue of Scientific Literature, and of its great importance to scientific workers, it is imperative to continue the publication of the catalogue beyond the first five annual issues. That this Resolution be communicated to the Regional Bureaus, requesting them to bring it under the notice of the contracting bodies and to obtain the necessary guarantees for the continuance of the work.

It was resolved: That the executive committee be authorized, in consultation with the Regional Bureaus, to spend a sum not exceeding £100 in making the catalogue known.

On the motion of the chairman it was resolved: That a representative of Russia be added to the executive committee, and that steps be taken to invite countries not yet represented on the Catalogue (Spain, Balkan States and South American Republics, etc.) to establish Regional Bureaus.

It was resolved: That the council accede to an application of the University of Ottawa, Canada, for the replacement of volumes of the catalogue lost in a conflagration which destroyed the whole of the university buildings including the library.

A motion by Professor Korteweg to place copies of the catalogue at a reduced price at the disposal of the regional bureaus for the use of the experts was discussed and withdrawn, the feeling being that, although desirable, the financial position of the catalogue did not yet admit of such a step being taken.

The proposal to extend the scope of the catalogue by the publication of additional series of volumes dealing with such subjects as (*a*) Medicine and Surgery, (*b*) Agriculture, Horticulture and Forestry, (*c*) Technology (various branches), was discussed, and the opinion expressed that it was desirable that the executive committee should take the matter into further consideration, in order that it may be brought under the notice of the International Convention in July, 1905.

It was resolved: That all alterations proposed in the schedules shall be collected and edited by the central bureau; that the amended schedules, together with the proposals of the bureaus, shall be submitted to the regional bureaus for their opinion; and that the final editing of the schemes to be submitted for the approval of the International Convention be entrusted to a committee of five persons, to be nominated by the executive committee.

SCIENTIFIC NOTES AND NEWS.

THE University of Michigan has conferred its doctorate of laws on Dr. F. H. Gerrish, professor of anatomy in Bowdoin Medical College.

THE degree of doctor of science has been conferred by Lafayette College on Francis P. Venable, president of the University of North Carolina and formerly professor of chemistry.

THE Western University of Pennsylvania, at its commencement held on June 16, conferred the degree of Sc.D. on Mr. Frank Hurlbut Chittenden, assistant entomologist of the United States Department of Agriculture, Washington, D. C.

THE University of Dublin has conferred the doctorate of science as follows: J. Dewar, Jacksonian professor of experimental philosophy, Cambridge, and Fullerian professor of chemistry at the Royal Institution; Professor J. H. van't Hoff, Berlin; Professor F. Klein, Göttingen; Major R. Ross, C.B., F.R.G.S., professor of tropical medicine, Liverpool; J. J. H. Teall, F.R.S., director of the Geological Survey of the United Kingdom; W. H. Thompson, King's professor of the institutes of medicine.

DR. J. T. ROTHROCK has, owing to ill health, resigned the position of forestry commissioner of the state of Pennsylvania. Mr. R. S. Conklin, present deputy commissioner, has been appointed his successor.

Professor V. M. Spalding, of the University of Michigan, has received a grant from the Carnegie Institution for the continuance of an investigation at the Desert Laboratory of the absorption and transpiration of water by the creosote bush and other desert shrubs. He will be located at Tucson, Arizona, during the winter of 1904–5.

The office of Vegetable, Physiological and Pathological Investigations of the Bureau of Plant Industry has arranged with Professor L. R. Jones, of the University of Vermont, to do some special work on the diseases of the potato. Professor Jones has been instructed to obtain all available information in regard to European varieties, and to obtain seed tubers of valuable sorts, especially disease-resistant strains, for testing in various sections of the United States. He has been appointed a temporary special agent of the Bureau of Plant Industry of the Department of Agriculture for this purpose and is now in Europe engaged in the work.

Mr. Thomas Manns, of the North Dakota Agricultural College, has resigned his position as instructor in botany and has accepted a position with the War Department in the Philippines. During the past two years Mr. Mann has been conducting investigations upon soil fungi as affecting the character of the crops upon the rotation plots of the Experiment Station. The results of this work are very promising and the board of trustees have instructed Professor H. L. Bolley of the department of botany to find a young man to continue the work.

Dr. J. W. Lowber, F.R.A.S., of Austin, Texas, has been elected a member of the Belgian Astronomical Society, Brussels.

Professor Henry Landes, head of the department of geology in the Washington State University, who has been absent studying at the University of Chicago during the year, will resume his work in Seattle next September.

Professor Alexander L. Nelson has celebrated the fiftieth anniversary of his professorship of mathematics at Washington and Lee University.

At the alumni dinner of the State University of Iowa, the former students of Professor Samuel Calvin, to the number of over two thousand, united in the commemoration of the completion of his thirtieth year in a professorship at that institution. The recognition took the form of a costly silver loving-cup, designed especially for the purpose of symbolizing the scientific achievements of the recipient. The cup is a classic Greek vase sixteen inches in height, and stands on a base of serpentine five inches high. It is adorned with casts taken directly from fossils, with a drainage-map of Iowa, with crossed geological hammers, a microscope, and the more conventional spray of laurel, owl of wisdom and torch of learning, —all in relief. One side bears an appropriate inscription in raised letters. Professor Calvin was elected to the chair of natural history in Iowa's university thirty years ago. The chair has since been subdivided into four distinct departments, Professor Calvin retaining the department of geology. He has been state geologist of Iowa during the last twelve years.

The Warren Triennial Prize of the value of $500, in the gift of the Massachusetts General Hospital, has been awarded to Dr. Max Borst, extraordinary professor of pathological anatomy in the University of Würzburg, for a dissertation entitled 'Neue Experimente zur Frage der Regenerationsfähigkeit des Gehirns.'

Dr. N. S. Davis, of Chicago, died on June 16, aged eighty-seven years. Dr. Davis was a voluminous writer on medical subjects and took an important part in the organization of the medical profession. He was, in 1845, chairman of a committee whose report led to the establishment of the American Medical Association, and he was the first editor of its journal.

Mr. Andrew Carnegie has given £1,200 to the Royal Institution, to enable Professor Dewar and Mr. R. A. Hadfield to prosecute their investigation on the physical properties of steel and other alloys at low temperatures; Dr. Frank McClean has given £100 to the research fund of the institution.

It is said that Colonel Gorgas, chief sanitary officer of the Isthmian Canal, estimates

that three hundred special physicians will be required during the progress of the war. These physicians will be in addition to surgeons of the army and navy, and will be selected from those who have recently graduated and completed hospital service.

THERE is wanted an economic geologist and paleontologist in the Mining Bureau at Manila, P. I., the salary of the position being $2,000. Applicants must satisfy the U. S. Civil Service Board, but should write directly to the Chief of the Mining Bureau, Manila, P. I.

WE learn from *Nature* that a meeting of members of the council of the South African Association for the Advancement of Science was held at Johannesburg, on May 19, Mr. T. Reunert presiding. The chairman reported that he had been in communication with the German, French, Austrian and Italian consuls, and was hopeful of the cooperation of these gentlemen in connection with the visit of continental delegates to South Africa with the British Association next year. Dr. Pakes, referring to the impending departure of Mr. Reunert for England, mentioned that he would represent the South African Association at the forthcoming Cambridge meeting of the British Association.

THE Institution of Civil Engineers gave a *conversazione* on June 15 at the institution premises. The guests, who numbered about 1,200, were received by Sir William H. White, the president, and Lady White and the members of the council.

THE *Discovery* and the *Morning* have sailed from Lyttleton, New Zealand, for Plymouth.

The British Medical Joural states that a number of French medical men who take an interest in English medicine and surgery propose to visit London next October in order to see something of the hospitals and laboratories. An influential committee has been formed in Paris, and a small organizing committee, of which Dr. Triboulet is president. Among the senior members of the Paris faculty who have expressed their intention of joining the party are Professors Bouchard, Lucas-Championnière, Chauffard, Landouzy, Lermoyez, Marie and Sebileau.

A LETTER from Dr. C. Nordmann to the *Revue générale des Sciences*, abstracted in *Nature*, describes a new astrophysical observatory which has just been built near to Tortosa, in Spain, in latitude 40° 48′ N. and longitude 1° 47′ E. of Paris. The general idea of the work to be prosecuted is to obtain information regarding the relations between solar and terrestrial phenomena. Two magnetic houses have been equipped, the one for absolute measures of terrestrial magnetism, the other for obtaining records of the regular variations in the elements and of the extraordinary disturbances which appear to coincide, in point of time, with solar disturbances. The observatory is also to be furnished with an equatorial for observing sun-spots, an Evershed photo-spectroheliograph, and an instrument for determining the radial velocities of solar prominence eruptions. Another building has been set apart for meteorological observations and the study of atmospheric optics, and seismological observations have also been provided for.

THE committee appointed to enquire into the administration of the British Meteorological Council has made its report. We learn from the London *Times* that among its recommendations are the following: That the registration of the Meteorological Office as a company under the joint stock companies acts should be cancelled; that the company should be wound up, and the office reconstituted as a department under the control of the Board of Agriculture and Fisheries; that the office be placed under the control of a man of science as director of meteorology, appointed after consultation with the Royal Society, but responsible to the Board of Agriculture and Fisheries; that an advisory board be appointed, consisting of the hydrographer to the Admiralty, a representative of the Board of Trade, and one of the Board of Agriculture and Fisheries, and two members nominated by the Royal Society, the functions of the advisory board to be consultative only, the director being responsible to the Board of Agriculture and Fisheries for administration; that a second officer be appointed to act as scientific

assistant to the director; that the fixed Parliamentary grant of £15,300 be transferred to the vote for the Board of Agriculture and Fisheries; and that the post office should make arrangements at the 27 reporting stations in the United Kingdom for the transmission of daily telegraphic reports one hour earlier than the present one of 8:15 to 8:30 A.M., and that storm warnings should, if practicable, have priority over all private messages at all hours. The committee also call attention to the expediency of testing the efficacy of wireless telegraphy in providing advance news of weather in the Atlantic, and urge that no unnecessary delay should take place in organizing this experiment. They also recommend that in future the cost of instruments supplied to his Majesty's ships be borne upon the Navy Votes, except where such instruments are intended for use in research or observation specially called for by the director of meteorology, and they consider that the premises now rented by the council are neither suitable in character nor adequate in space for the present requirements of the office, and that others should be provided wherein the staff might perform their duties under more favorable hygienic conditions, and necessary accommodation for the rapidly growing library might be secured.

UNIVERSITY AND EDUCATIONAL NEWS.

The new laboratory of physics and engineering, given by Mr. William H. Reid, of Chicago, to Washington and Lee University, was dedicated on June 15.

At the recent commencement of the University of Nebraska three men graduated from the Department of Forestry which was established two years ago. These men on the establishment of forestry work in the university were transferred to this department from other departments of science, and thus were able to complete the course in two years. The full course is four years, and the requirements for admission to the freshman class are the same as for other departments of the university.

A department of medicine with a two-years' course has been added to the curriculum of the Washington State University. For the present the work will be in charge of Professor Byers, head of the department of chemistry. Dr. C. W. Johnson, assistant professor of pharmacy, has been made dean of the department of pharmacy.

A medical department will be established next year as part of St. John's College, a catholic institution at Fordham, New York City.

The Mercers' Company have given a donation of £1,000 to the Institute of Medical Science Fund (University of London), and the Clothworkers' Company have given £300.

Mr. Francis G. Smart, M.A., M.G., of Gonville and Caius College, has founded, in the University of Cambridge, a studentship of £100 a year, tenable two years, for the encouragement of botanical research.

It is announced that work on the buildings for the Harvard Medical School has not progressed as rapidly as had been hoped, and that they will probably not be occupied until the autumn of 1906, instead of 1905, as was originally expected.

At Cornell University, Mr. Carl P. Thomas, a graduate of the class of 1895, has been appointed assistant professor of marine engineering. Drs. James McMahon and John H. Tanner have been promoted to full professorships of mathematics.

Dr. A. N. Cook, who has been professor of chemistry in Morningside College, Sioux City, for the past four years, has been elected professor of chemistry in the State University of South Dakota at Vermillion.

Dr. C. H. Gordon, who has been acting professor of geology in the Washington State University during the past year, has accepted a call to the chair of geology in the New Mexico School of Mines.

Mr. Harry R. Fulton, assistant in biology in the University of Mississippi, has been awarded a fellowship in botany for 1904–5 in the University of Missouri.

Dr. Philip Henry Pye-Smith, M.D., F.R.S., has been reelected vice-chancellor of the University of London, for the year 1904–5.